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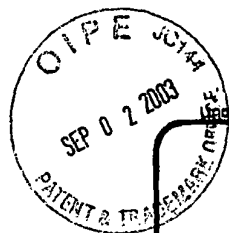
<b>TRANSMITTAL FORM</b>  (to be used for all correspondence after initial filing)	Application Number	10/038,352
	Filing Date	01/02/2002
	First Named Inventor	Kurt G. Steiner
	Art Unit	2812
	Examiner Name	H. T. Nguyen
Total Number of Pages in This Submission	Attorney Docket Number	075903-242

ENCLOSURES (Check all that apply)		
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<b>SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT</b>		
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Signature	Beusse Brownlee Bowdoin & Wolter, P.A.	
Date	August 27, 2003	

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# FEE TRANSMITTAL for FY 2003

Effective 01/01/2003 Patent fees are subject to annual revision.

☐ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT (\$)**320.00**

## Complete if Known

Application Number **10/038,352**  
Filing Date **01/02/02**  
First Named Inventor **Steiner, Kurt G.**  
Examiner Name **H. T. Nguyen**  
Art Unit  
Attorney Docket No. **075903-242**

## METHOD OF PAYMENT (check all that apply)

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## FEE CALCULATION

### 1. BASIC FILING FEE

Large Entity Small Entity

Fee Code (\$)	Fee Code (\$)	Fee Description	Fee Paid
1001 750	2001 375	Utility filing fee	
1002 330	2002 165	Design filing fee	
1003 520	2003 260	Plant filing fee	
1004 750	2004 375	Reissue filing fee	
1006 160	2005 80	Provisional filing fee	

SUBTOTAL (1) (\$)**-0-**

### 2. EXTRA CLAIM FEES FOR UTILITY AND REISSUE

Total Claims  Extra Claims  Fee from below  Fee Paid   
Independent Claims  - 3\*\* =  X   
Multiple Dependent

Large Entity Small Entity

Fee Code (\$)	Fee Code (\$)	Fee Description	Fee Paid
1202 18	2202 9	Claims in excess of 20	
1201 84	2201 42	Independent claims in excess of 3	
1203 280	2203 140	Multiple dependent claim, if not paid	
1204 84	2204 42	** Reissue independent claims over original patent	
1205 18	2205 9	** Reissue claims in excess of 20 and over original patent	

SUBTOTAL (2) (\$)**-0-**

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## FEE CALCULATION (continued)

### 3. ADDITIONAL FEES

Large Entity Small Entity

Fee Code (\$)	Fee Code (\$)	Fee Description	Fee Paid
1051 130	2051 65	Surcharge - late filing fee or oath	
1052 50	2052 25	Surcharge - late provisional filing fee or cover sheet	
1053 130	2053 65	Non-English specification	
1812 2,520	2812 1,260	For filing a request for ex parte reexamination	
1804 920	2804 460	Requesting publication of SIR prior to Examiner action	
1805 1,840	2805 920	Requesting publication of SIR after Examiner action	
1251 110	2251 55	Extension for reply within first month	
1252 410	2252 205	Extension for reply within second month	
1253 930	2253 465	Extension for reply within third month	
1254 1,450	2254 725	Extension for reply within fourth month	
1255 1,970	2255 985	Extension for reply within fifth month	
1401 320	2401 160	Notice of Appeal	
1402 320	2402 160	Filing a brief in support of an appeal	320.00
1403 280	2403 140	Request for oral hearing	
1451 1,510	2451 755	Petition to institute a public use proceeding	
1452 110	2452 55	Petition to revive - unavoidable	
1453 1,300	2453 650	Petition to revive - unintentional	
1501 1,300	2501 650	Utility issue fee (or reissue)	
1502 470	2502 235	Design issue fee	
1603 630	2603 315	Plant issue fee	
1480 130	2480 65	Petitions to the Commissioner	
1807 50	2807 25	Processing fee under 37 CFR 1.17(q)	
1808 180	2808 90	Submission of Information Disclosure Sheet	
8021 40	28021 20	Recording each patent assignment per property (times number of properties)	
1809 750	2809 375	Filing a submission after final rejection (37 CFR 1.129(a))	
1810 750	2810 375	For each additional invention to be examined (37 CFR 1.129(b))	
1801 750	2801 375	Request for Continued Examination (RCE)	
1802 900	2802 450	Request for expedited examination of a design application	

Other fee (specify)

\*Reduced by Basic Filing Fee Paid

SUBTOTAL (3) (\$)**320.00**

## SUBMITTED BY

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Signature

Date

**August 27, 2003**

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**In the United States Patent and Trademark Office  
Before the Board of Patent Appeals and Interferences**

In re Application of:  
Steiner, et al.  
Serial No.: 10/038,352  
Filed: 01/02/2002  
For: Structure and Method for Isolating Porous  
Low-K Dielectric Films

Group Art Unit: 2812  
Examiner: H.T.Nguyen  
Appeal No.

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Alexandria, VA 22313-1450

**BRIEF OF APPELLANT**

This brief is in furtherance of the Notice of Appeal filed in this case on **June 30, 2003** from the final rejection of the Examiner dated March 31, 2003 rejecting Claims 1, 2, 4-17, 26 and 27. The fees required under §1.17 are dealt with in the accompanying documents. This brief is transmitted in triplicate.

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## I. REAL PARTY IN INTEREST

The real party in interest in this appeal is the assignee of the present application, Agere Systems, Inc., a corporation of the State of Delaware.

## II. RELATED APPEALS

There is no other appeal or interference that will directly affect, or that will be directly affected by, or that will have a bearing on the Board's decision in this appeal.

## II. STATUS OF CLAIMS

The application was filed on January 2, 2002 with twenty-five (25) claims of which three (3) claims were independent claims (Claims 1, 13, and 18). The examiner issued a restriction requirement on August 8, 2002 for the following groups: Group I: Claims 18 - 25; Group II: Claims 1 - 17. In Applicants' response dated September 10, 2002, Applicant elected Group II: Claims 1 - 17 without traverse. In response to an October 23, 2002 Office Action, Applicants cancelled claims 3, 18 - 25, and added new claims 26 - 27.

Accordingly, the status of the claims in the application is as follows:

A. Total claims in original application: Claims 1 - 25.

B. Current status of all the Claims:

1. Claims cancelled: 3, 18 - 25
2. Claims withdrawn from consideration but not cancelled: none
3. Claims added: 26, 27
3. Claims pending: 1, 2, 4 - 17, 26, 27
4. Claims allowed: none
5. Claims rejected: 1, 2, 4 - 17, 26, 27

C. Claims on appeal are: 1, 2, 4 - 17, 26, 27

## IV. STATUS OF AMENDMENTS

No claim amendments were filed in response to the final Office Action. The claims are set out in the Appendix.

## V. SUMMARY OF THE INVENTION

The Applicant's invention is directed to a method and structure for isolating low-k dielectric layers from nitrogen base layers that include N-H base groups which are capable of diffusing from the nitrogen base layer and becoming nested in the low-k dielectric layer. The present invention provides an oxygen-containing layer disposed directly between the low-k dielectric layer and the nitrogen base layer. The present invention also provides a process for forming a semiconductor product which includes forming at least one low-k dielectric film over a substrate, forming at least one N-H base film over the substrate, and forming a TEOS (tetraethyl orthosilicate) oxide film between at least one adjacent set of a low-k dielectric film and an N-H base film. [SPEC. p. 2, lines 11 – 20]. The nitrogen base layers may be nitrogen-containing films such as silicon nitride (SiN) or nitrogen-doped silicon carbide (SiC-N) [SPEC. p. 3, lines 15 – 17]. A fundamental concept of the present invention is that each adjacent film set of a low-k dielectric film and a nitrogen base layer is separated by a TEOS or other oxygen-containing film, which suppresses diffusion of base species from the base-containing course film to the low-k dielectric material. [SPEC. p. 7, lines 22 – 25]. Due to the oxygen-containing films 12, 24, 36 and 48 of the present invention, low-k dielectric films 18 and 42 do not include N-H base groups or other nitrogen-containing base groups such as amines or amino-silicates. [SPEC. p. 9, lines 9 – 12].

## VI. ISSUES

A. Whether Claims 1, 4, 6, 11, 26, and 27 are unpatentable (35 U.S.C. 103) over Kudo (U.S. Patent No. 6,420,261). The Kudo reference is relied on by the Examiner to show that by substituting a combination of SiC and Si oxide for the Si oxide as the oxygen-containing layer 55 between the low-k dielectric layer 54 and a nitrogen base layer (silicon nitride) 61, the interface between layers 61 and 55 will contain nitrogen-doped silicon carbide.

B. Whether Claims 2, 7, 9, 13, and 14 are unpatentable (35 U.S.C. 103) over Kudo (U.S. Patent No. 6,420,261) in view of Huang (U.S. Patent No. 6,191,028). The Kudo reference

is relied on by the Examiner as described above with respect to *Issue A*. The Huang reference is relied on by the Examiner to show that the limitation of TEOS is obvious.

C. Whether Claims 5, 8, 10, 12, and 15 - 17 are unpatentable (35 U.S.C. 103) over Kudo (U.S. Patent No. 6,420,261) in view of Huang (U.S. Patent No. 6,191,028) further in view of Liu (U.S. Patent No. 6,323,121). The Kudo and Huang references are relied on by the Examiner as described above with respect to *Issues A and B*. The Liu reference is relied on by the Examiner to show the opening extending through the etch stop layer and the lower dielectric layer and the use of organo-silicate glass as low-k dielectric material.

#### V. GROUPING OF CLAIMS

As to the rejections applied against Claims 1, 4, 6, 11, 26, and 27 (35 U.S.C. 103), it is Applicants' intention that the rejected claims do not stand or fall together. Claims 1, 4, 6, 11 should be grouped together while Claims 26 and 27 should be grouped separately from Claims 1, 4, 6, 11 for purposes of consideration in this appeal since Claims 26 - 27 include an oxygen-doped silicon carbide layer while Claims 1, 4, 6, 11 include a nitrogen-doped silicon carbide layer.

As to the rejections applied against Claims 2, 7, 9, 13, and 14 (35 U.S.C. 103), it is Applicants' intention that the rejected claims stand or fall together.

As to the rejections applied against Claims 5, 8, 10, 12, and 15 - 17 (35 U.S.C. 103), it is Applicants' intention that the rejected claims stand or fall together.

## VI. ARGUMENT

*A. The rejection of Claims 1, 4, 6, 11, 26, and 27 as unpatentable (35 U.S.C. 103) over Kudo (U.S. Patent No. 6,420,261).*

With respect to Claims 1, 4, 6, 11, Independent Claim 1 is directed to a semiconductor product comprising three layers: (Layer 1) a low-k dielectric layer, (Layer 2) an oxygen containing layer (e.g., SiO<sub>2</sub>), and (Layer 3) a nitrogen base layer formed of nitrogen-doped silicon carbide (SiC-N). Claims 4, 6, and 11 depend therefrom.

Kudo, U.S. Patent No. 6,420,261, is directed to a semiconductor device manufacturing method. Kudo discloses a first organic insulating film 54 of low dielectric constant (i.e., Layer 1). Kudo discloses a second silicon oxide (SiO<sub>2</sub>) film 55 (i.e., Layer 2) and a silicon nitride (Si<sub>3</sub>N<sub>4</sub>) film 61 (i.e., Layer 3). With respect to claims 1, 4, 6, and 11, Kudo fails to teach the specific claim limitation of “a nitrogen base layer formed of nitrogen-doped silicon carbide (SiC-N)”. In rejecting claims 1, 4, 6, 11, the examiner has substituted a combination of SiC and SiO<sub>2</sub> for the SiO<sub>2</sub> disclosed in Kudo (relying on the disclosure that an SiC film may be employed *in place of* SiO<sub>2</sub> film). The examiner then contends that the interface between film 55 (Layer 2) and film 61 (Layer 3) will contain nitrogen-doped silicon carbide (SiC-N).

Applicant submits, however, Kudo lacks any suggestion that it should be modified in the manner set forth by the examiner. While it is true that Kudo teaches the *substitution* of an SiC film for an SiO<sub>2</sub> film [Kudo, Col. 9, lines 30 – 31, “In this case, the silicon containing insulating film such as an Si<sub>3</sub>N<sub>4</sub> film, an SiON film, an SiC film, etc. may be employed in place of the above SiO<sub>2</sub> films.”], it does not teach or suggest the substitution of a *combination* of SiC and SiO<sub>2</sub> for the SiO<sub>2</sub> film nor does it teach the addition of SiC to the SiO<sub>2</sub> film. Instead of using the explicit teachings of Kudo and *replacing* SiO<sub>2</sub> with SiC, the examiner incorrectly modified Kudo by *adding* SiC to the SiO<sub>2</sub> film. Had the examiner employed the actual teachings of Kudo, he would have either substituted the SiC film for the SiO<sub>2</sub> film resulting in a semiconductor product lacking an oxygen-containing layer required by the claims, or he would have kept the SiO<sub>2</sub> resulting is a product lacking nitrogen-doped silicon carbide.

As such, the examiner has misapplied the reference and has made an unsuggested



modification. Accordingly, with respect to claims 1, 4, 6, and 11, Applicant submits that the invention, as claimed, is patentable over Kudo and that the rejection should be withdrawn.

With respect to Claims 26 – 27, Independent Claim 26 is directed to a semiconductor product comprising three layers: (Layer 1) a low-k dielectric layer, (Layer 2) an oxygen-doped silicon carbide layer, and (Layer 3) a nitrogen base layer. Claim 27 depends therefrom. With respect to claims 26 and 27, Kudo fails to teach or suggest the specific claim limitation of “an oxygen-doped silicon carbide layer.” Kudo describes a first organic insulating film 54 of low dielectric constant (i.e., Layer 1). Kudo discloses a second silicon oxide ( $\text{SiO}_2$ ) film 55 (i.e., Layer 2) and a silicon nitride ( $\text{Si}_3\text{N}_4$ ) film 61 (i.e., Layer 3). While it is true that Kudo teaches the substitution of an SiC film for an  $\text{SiO}_2$  film [Col. 9, lines 30 – 31], such a substitution would not meet the specific limitations of the claims. Specifically, following the teachings of Kudo, the resulting embodiment would not contain an oxygen-doped silicon carbide layer as required by the claims. As such, the examiner has misapplied the reference and has made an unsuggested modification. Accordingly, with respect to claims 26 and 27, Applicant submits that the invention, as claimed, is patentable over Kudo and that the rejection should be withdrawn.

*B. The rejection of Claims 2, 7, 9, 13, and 14 as unpatentable (35 U.S.C. 103) over Kudo (U.S. Patent No. 6,420,261) in view of Huang (U.S. Patent No. 6,191,028).*

With respect to claims 2, 7, 9, 13, and 14, in addition to the above-noted arguments with respect to claim 1, Kudo, the primary reference, teaches nothing about using an oxygen-containing layer comprised of TEOS. Huang describes an insulation-masking layer formed by CVD using TEOS. Apparently, the examiner has again substituted a *combination* of SiC and  $\text{SiO}_2$  for the  $\text{SiO}_2$ . Had the examiner employed the actual teachings of Kudo, he would have substituted the SiC film for the  $\text{SiO}_2$  film resulting in a semiconductor product lacking an oxygen-containing layer required by the claims. The product would then, necessarily, lack an oxygen-containing layer comprised of TEOS, even if combined with Huang.

The Examiner has attempted to combine Kudo with Huang in rejecting Claims 2, 7, 9, 13, and 14. However, the examiner has misapplied the Kudo reference and has made an

unsuggested modification. Accordingly, Applicant submits that the invention, as claimed, is patentable over Kudo in view of Huang and that the rejection should be withdrawn. It is Applicant's position that the combination does not teach the Applicant's basic inventive concept of a semiconductor product comprising three layers: (Layer 1) a low-k dielectric layer, (Layer 2) an oxygen containing layer (e.g., SiO<sub>2</sub>), and (Layer 3) a nitrogen base layer formed of nitrogen-doped silicon carbide (SiC-N), and that the addition of Huang to show an oxygen-containing layer comprised of TEOS contributes no further to the question of the patentability of the claims in as much as following the teachings of Kudo would result in a lack of an oxygen-containing layer altogether.

As such, it is submitted that neither of these references, alone or in combination, describes or suggests the Applicant's invention as claimed. Accordingly, with respect to claims 2, 7, 9, 13, and 14, Applicant submits that the invention, as claimed, is patentable over Kudo in view of Huang and that the rejection should be withdrawn.

*C. The rejection of Claims 5, 8, 10, 12, and 15 - 17 as unpatentable (35 U.S.C. 103) over Kudo (U.S. Patent No. 6,420,261) in view of Huang (U.S. Patent No. 6,191,028) further in view of Liu (U.S. Patent No. 6,323,121).*

With respect to dependent claims 5, 8, 10, and 12, each of said claims depends on Claim 1. As set forth with respect to Issue A, Independent Claim 1 is directed to a semiconductor product comprising three layers: (Layer 1) a low-k dielectric layer, (Layer 2) an oxygen containing layer (e.g., SiO<sub>2</sub>), and (Layer 3) a nitrogen base layer formed of nitrogen-doped silicon carbide (SiC-N). As such, the arguments with respect to the patentability of Claim 1 apply equally to claims 5, 8, 10, and 12.

With respect to claims 15 – 17, each of said claims depends on Claim 13, which includes a layer of nitrogen-doped silicon carbide (as in Claim 1). As such, the arguments with respect to the patentability of Claim 1 apply equally to claims 15 – 17.

In addition to the above-noted arguments with respect to claim 1, Kudo, the primary reference, teaches nothing about using an oxygen-containing layer comprised of oxygen-doped

silicon carbide (Claim 5) nor using an oxygen-containing layer comprised of TEOS (Claim 8, and 15 – 17). Huang describes an insulation-masking layer formed by CVD using TEOS. Liu describes a wafer substructure 10, insulative layer 12, silicon nitride layer 16, low-k dielectric layer 18, silicon nitride layer 20, second low-k dielectric layer 22, silicon oxynitride layer 24.

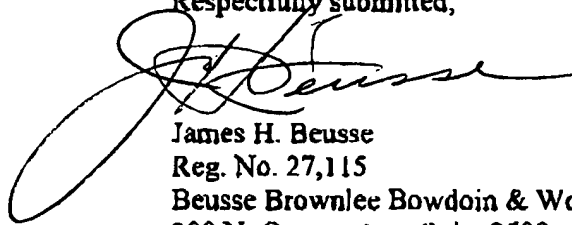
As set forth above with respect to Issues A and B, had the examiner employed the actual teachings of Kudo, he would have substituted the SiC film for the SiO<sub>2</sub> film resulting in a semiconductor product lacking an oxygen-containing layer required by the claims. The product would then, necessarily, lack an oxygen-containing layer comprised of oxygen-doped silicon carbide or TEOS, even if combined with Huang and/or Liu.

Accordingly, Applicant submits that the invention, as claimed, is patentable over Kudo in view of Huang and Liu and that the rejection should be withdrawn. It is Applicant's position that the combination does not teach the Applicant's basic inventive concept of a semiconductor product comprising three layers: (Layer 1) a low-k dielectric layer, (Layer 2) an oxygen containing layer (e.g., SiO<sub>2</sub>), and (Layer 3) a nitrogen base layer formed of nitrogen-doped silicon carbide (SiC-N), and that the addition of Huang to show an oxygen-containing layer comprised of TEOS contributes no further to the question of the patentability of the claims in as much as the proper combination would result in a lack of an oxygen-containing layer altogether.

As such, it is submitted that none of these references, alone or in combination, describes or suggests the Applicant's invention as claimed. Accordingly, with respect to claims 5, 8, 10, 12, and 15 - 17, Applicant submits that the invention, as claimed, is patentable over Kudo in view of Huang and/or Liu, and that the rejection should be withdrawn.

In view of the foregoing, Applicant urges that the Board overrule the outstanding rejections, and that this application be passed to issuance.

Respectfully submitted,

A handwritten signature in black ink, appearing to read 'J. Beusse', with a large, stylized loop at the beginning.

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Attachment: Appendix

APPENDIX (37 C.F.R. 1.192(c)(7))

Claims on Appeal:

1. A semiconductor product comprising:  
a low-k dielectric layer;  
a nitrogen base layer formed of nitrogen-doped silicon carbide and including N-H base groups capable of diffusing therefrom; and  
an oxygen-containing layer interposed directly between said low-k dielectric layer and said nitrogen base layer.
2. The semiconductor product as in claim 1, wherein said oxygen-containing layer comprises a TEOS (tetraethyl orthosilicate) oxide film
4. The semiconductor product as in claim 1, wherein said nitrogen base layer comprises one of a barrier layer film, an etch-stop layer, and a hardmask film.
5. The semiconductor product as in claim 1, wherein said oxygen-containing layer comprises oxygen-doped silicon carbide.
6. The semiconductor product as in claim 1, wherein said nitrogen base layer comprises a surface of a further film.
7. The semiconductor product as in claim 1, in which said semiconductor product includes:  
a lower low-k dielectric layer disposed over a barrier layer;  
an etch-stop layer disposed over said lower low-k dielectric layer;  
an upper low-k dielectric layer disposed over said etch-stop layer;  
a hardmask layer disposed over said upper low-k dielectric layer;  
said nitrogen base layer comprising one of said barrier layer and said etch-stop layer; and  
said oxygen-containing layer comprising a TEOS oxide layer interposed between said

nitrogen base layer and one of said lower low-k dielectric layer and said upper low-k dielectric layer.

8. The semiconductor product as in claim 7, further comprising each of said barrier layer, said etch-stop layer and said hardmask layer being a nitrogen base layer, and a TEOS oxide layer interposed between each said nitrogen base layer and each said adjacent low-k dielectric layer.

9. The semiconductor product as in claim 7, wherein said barrier layer comprises one of said nitrogen base layer formed of nitrogen-doped silicon carbide, and silicon nitride; and said etch-stop layer comprises the other of said nitrogen base layer formed of nitrogen-doped silicon carbide, and silicon nitride.

10. The semiconductor product as in claim 1, wherein said N-H base groups comprise one of amines and amino-silicates.

11. The semiconductor product as in claim 1, wherein said low-k dielectric layer includes a dielectric constant less than 3.5.

12. The semiconductor product as in claim 1, wherein said low-k dielectric layer comprises one of an organo-silicate-glass and SiOC-H.

13. A semiconductor product comprising:  
a barrier layer formed over a substrate;  
a lower low-k dielectric layer formed over said barrier layer;  
an etch-stop layer formed over said lower low-k dielectric layer;  
an upper low-k dielectric layer formed over said etch-stop layer;  
a hardmask layer disposed over said upper low-k dielectric layer; and  
a TEOS (tetraethyl orthosilicate) oxide film interposed at least one of between said lower low-k dielectric layer and said barrier layer, between said lower low-k dielectric layer and said

etch-stop layer, between said etch-stop layer and said upper low-k dielectric layer, and between said upper low-k dielectric layer and said hardmask,

at least one of said barrier layer and said etch-stop layer formed of nitrogen-doped silicon carbide.

14. The semiconductor product as in claim 13, wherein each of said barrier layer and said etch-stop layer include N-H base groups therein.

15. The semiconductor product as in claim 13, in which a two-tiered opening is formed to extend through said hardmask layer, said upper low-k dielectric layer, said etch-stop layer, said lower low-k dielectric layer, and said barrier layer.

16. The semiconductor product as in claim 15, further comprising a conductive material filling said two-tiered opening, said conductive material serving as an interconnect medium.

17. The semiconductor product as in claim 13, in which an opening is formed to extend through said hardmask layer, said upper low-k dielectric layer, said etch-stop layer and said lower low-k dielectric layer, and further comprising a DUV photoresist formed within said opening.

26. A semiconductor product comprising:  
a low-k dielectric layer;  
a nitrogen base layer including N-H base groups capable of diffusing therefrom; and  
an oxygen-doped silicon carbide layer interposed directly between said low-k dielectric layer and said nitrogen base layer.

27. The semiconductor product as in claim 26, wherein said nitrogen base layer is formed of nitrogen-doped silicon carbide.



**In the United States Patent and Trademark Office  
Before the Board of Patent Appeals and Interferences**

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In re Application of:

Steiner, et al.

Serial No.: 10/038,352

Filed: 01/02/2002

For: Structure and Method for Isolating Porous  
Low-K Dielectric Films

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Group Art Unit: 2812

Examiner: H.T.Nguyen

Appeal No.

Mail Stop Appeal Briefs - Patents

Commissioner for Patents

P.O. Box 1450

Alexandria, VA 22313-1450

**BRIEF OF APPELLANT**

This brief is in furtherance of the Notice of Appeal filed in this case on **June 30, 2003** from the final rejection of the Examiner dated March 31, 2003 rejecting Claims 1, 2, 4-17, 26 and 27. The fees required under §1.17 are dealt with in the accompanying documents. This brief is transmitted in triplicate.

**CERTIFICATE OF MAILING**

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date shown below:

Alicia Hoffman

(Typed or Printed Name of Person Signing Certificate)

Alicia Hoffman

(Signature)

8-27-03

(Date)



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## I. REAL PARTY IN INTEREST

The real party in interest in this appeal is the assignee of the present application, Agere Systems, Inc., a corporation of the State of Delaware.

## II. RELATED APPEALS

There is no other appeal or interference that will directly affect, or that will be directly affected by, or that will have a bearing on the Board's decision in this appeal.

## II. STATUS OF CLAIMS

The application was filed on January 2, 2002 with twenty-five (25) claims of which three (3) claims were independent claims (Claims 1, 13, and 18). The examiner issued a restriction requirement on August 8, 2002 for the following groups: Group I: Claims 18 - 25; Group II: Claims 1 - 17. In Applicants' response dated September 10, 2002, Applicant elected Group II: Claims 1 - 17 without traverse. In response to an October 23, 2002 Office Action, Applicants cancelled claims 3, 18 - 25, and added new claims 26 - 27.

Accordingly, the status of the claims in the application is as follows:

A. Total claims in original application: Claims 1 - 25.

B. Current status of all the Claims:

1. Claims cancelled: 3, 18 - 25
2. Claims withdrawn from consideration but not cancelled: none
3. Claims added: 26, 27
3. Claims pending: 1, 2, 4 - 17, 26, 27
4. Claims allowed: none
5. Claims rejected: 1, 2, 4 - 17, 26, 27

C. Claims on appeal are: 1, 2, 4 - 17, 26, 27

## IV. STATUS OF AMENDMENTS

No claim amendments were filed in response to the final Office Action. The claims are set out in the Appendix.

## V. SUMMARY OF THE INVENTION

The Applicant's invention is directed to a method and structure for isolating low-k dielectric layers from nitrogen base layers that include N-H base groups which are capable of diffusing from the nitrogen base layer and becoming nested in the low-k dielectric layer. The present invention provides an oxygen-containing layer disposed directly between the low-k dielectric layer and the nitrogen base layer. The present invention also provides a process for forming a semiconductor product which includes forming at least one low-k dielectric film over a substrate, forming at least one N-H base film over the substrate, and forming a TEOS (tetraethyl orthosilicate) oxide film between at least one adjacent set of a low-k dielectric film and an N-H base film. [SPEC. p. 2, lines 11 – 20]. The nitrogen base layers may be nitrogen-containing films such as silicon nitride (SiN) or nitrogen-doped silicon carbide (SiC-N) [SPEC. p. 3, lines 15 – 17]. A fundamental concept of the present invention is that each adjacent film set of a low-k dielectric film and a nitrogen base layer is separated by a TEOS or other oxygen-containing film, which suppresses diffusion of base species from the base-containing course film to the low-k dielectric material. [SPEC. p. 7, lines 22 – 25]. Due to the oxygen-containing films 12, 24, 36 and 48 of the present invention, low-k dielectric films 18 and 42 do not include N-H base groups or other nitrogen-containing base groups such as amines or amino-silicates. [SPEC. p. 9, lines 9 – 12].

## VI. ISSUES

A. Whether Claims 1, 4, 6, 11, 26, and 27 are unpatentable (35 U.S.C. 103) over Kudo (U.S. Patent No. 6,420,261). The Kudo reference is relied on by the Examiner to show that by substituting a combination of SiC and Si oxide for the Si oxide as the oxygen-containing layer 55 between the low-k dielectric layer 54 and a nitrogen base layer (silicon nitride) 61, the interface between layers 61 and 55 will contain nitrogen-doped silicon carbide.

B. Whether Claims 2, 7, 9, 13, and 14 are unpatentable (35 U.S.C. 103) over Kudo (U.S. Patent No. 6,420,261) in view of Huang (U.S. Patent No. 6,191,028). The Kudo reference

is relied on by the Examiner as described above with respect to *Issue A*. The Huang reference is relied on by the Examiner to show that the limitation of TEOS is obvious.

C. Whether Claims 5, 8, 10, 12, and 15 - 17 are unpatentable (35 U.S.C. 103) over Kudo (U.S. Patent No. 6,420,261) in view of Huang (U.S. Patent No. 6,191,028) further in view of Liu (U.S. Patent No. 6,323,121). The Kudo and Huang references are relied on by the Examiner as described above with respect to *Issues A and B*. The Liu reference is relied on by the Examiner to show the opening extending through the etch stop layer and the lower dielectric layer and the use of organo-silicate glass as low-k dielectric material.

#### V. GROUPING OF CLAIMS

As to the rejections applied against Claims 1, 4, 6, 11, 26, and 27 (35 U.S.C. 103), it is Applicants' intention that the rejected claims do not stand or fall together. Claims 1, 4, 6, 11 should be grouped together while Claims 26 and 27 should be grouped separately from Claims 1, 4, 6, 11 for purposes of consideration in this appeal since Claims 26 - 27 include an oxygen-doped silicon carbide layer while Claims 1, 4, 6, 11 include a nitrogen-doped silicon carbide layer.

As to the rejections applied against Claims 2, 7, 9, 13, and 14 (35 U.S.C. 103), it is Applicants' intention that the rejected claims stand or fall together.

As to the rejections applied against Claims 5, 8, 10, 12, and 15 - 17 (35 U.S.C. 103), it is Applicants' intention that the rejected claims stand or fall together.

## VI. ARGUMENT

*A. The rejection of Claims 1, 4, 6, 11, 26, and 27 as unpatentable (35 U.S.C. 103) over Kudo (U.S. Patent No. 6,420,261).*

With respect to Claims 1, 4, 6, 11, Independent Claim 1 is directed to a semiconductor product comprising three layers: (Layer 1) a low-k dielectric layer, (Layer 2) an oxygen containing layer (e.g., SiO<sub>2</sub>), and (Layer 3) a nitrogen base layer formed of nitrogen-doped silicon carbide (SiC-N). Claims 4, 6, and 11 depend therefrom.

Kudo, U.S. Patent No. 6,420,261, is directed to a semiconductor device manufacturing method. Kudo discloses a first organic insulating film 54 of low dielectric constant (i.e., Layer 1). Kudo discloses a second silicon oxide (SiO<sub>2</sub>) film 55 (i.e., Layer 2) and a silicon nitride (Si<sub>3</sub>N<sub>4</sub>) film 61 (i.e., Layer 3). With respect to claims 1, 4, 6, and 11, Kudo fails to teach the specific claim limitation of “a nitrogen base layer formed of nitrogen-doped silicon carbide (SiC-N)”. In rejecting claims 1, 4, 6, 11, the examiner has substituted a combination of SiC and SiO<sub>2</sub> for the SiO<sub>2</sub> disclosed in Kudo (relying on the disclosure that an SiC film may be employed *in place of* SiO<sub>2</sub> film). The examiner then contends that the interface between film 55 (Layer 2) and film 61 (Layer 3) will contain nitrogen-doped silicon carbide (SiC-N).

Applicant submits, however, Kudo lacks any suggestion that it should be modified in the manner set forth by the examiner. While it is true that Kudo teaches the *substitution* of an SiC film for an SiO<sub>2</sub> film [Kudo, Col. 9, lines 30 – 31, “In this case, the silicon containing insulating film such as an Si<sub>3</sub>N<sub>4</sub> film, an SiON film, an SiC film, etc. may be employed in place of the above SiO<sub>2</sub> films.”], it does not teach or suggest the substitution of a *combination* of SiC and SiO<sub>2</sub> for the SiO<sub>2</sub> film nor does it teach the addition of SiC to the SiO<sub>2</sub> film. Instead of using the explicit teachings of Kudo and *replacing* SiO<sub>2</sub> with SiC, the examiner incorrectly modified Kudo by *adding* SiC to the SiO<sub>2</sub> film. Had the examiner employed the actual teachings of Kudo, he would have either substituted the SiC film for the SiO<sub>2</sub> film resulting in a semiconductor product lacking an oxygen-containing layer required by the claims, or he would have kept the SiO<sub>2</sub> resulting is a product lacking nitrogen-doped silicon carbide.

As such, the examiner has misapplied the reference and has made an unsuggested

modification. Accordingly, with respect to claims 1, 4, 6, and 11, Applicant submits that the invention, as claimed, is patentable over Kudo and that the rejection should be withdrawn.

With respect to Claims 26 – 27, Independent Claim 26 is directed to a semiconductor product comprising three layers: (Layer 1) a low-k dielectric layer, (Layer 2) an oxygen-doped silicon carbide layer, and (Layer 3) a nitrogen base layer. Claim 27 depends therefrom. With respect to claims 26 and 27, Kudo fails to teach or suggest the specific claim limitation of “an oxygen-doped silicon carbide layer.” Kudo describes a first organic insulating film 54 of low dielectric constant (i.e., Layer 1). Kudo discloses a second silicon oxide ( $\text{SiO}_2$ ) film 55 (i.e., Layer 2) and a silicon nitride ( $\text{Si}_3\text{N}_4$ ) film 61 (i.e., Layer 3). While it is true that Kudo teaches the substitution of an SiC film for an  $\text{SiO}_2$  film [Col. 9, lines 30 – 31], such a substitution would not meet the specific limitations of the claims. Specifically, following the teachings of Kudo, the resulting embodiment would not contain an oxygen-doped silicon carbide layer as required by the claims. As such, the examiner has misapplied the reference and has made an unsuggested modification. Accordingly, with respect to claims 26 and 27, Applicant submits that the invention, as claimed, is patentable over Kudo and that the rejection should be withdrawn.

*B. The rejection of Claims 2, 7, 9, 13, and 14 as unpatentable (35 U.S.C. 103) over Kudo (U.S. Patent No. 6,420,261) in view of Huang (U.S. Patent No. 6,191,028).*

With respect to claims 2, 7, 9, 13, and 14, in addition to the above-noted arguments with respect to claim 1, Kudo, the primary reference, teaches nothing about using an oxygen-containing layer comprised of TEOS. Huang describes an insulation-masking layer formed by CVD using TEOS. Apparently, the examiner has again substituted a *combination* of SiC and  $\text{SiO}_2$  for the  $\text{SiO}_2$ . Had the examiner employed the actual teachings of Kudo, he would have substituted the SiC film for the  $\text{SiO}_2$  film resulting in a semiconductor product lacking an oxygen-containing layer required by the claims. The product would then, necessarily, lack an oxygen-containing layer comprised of TEOS, even if combined with Huang.

The Examiner has attempted to combine Kudo with Huang in rejecting Claims 2, 7, 9, 13, and 14. However, the examiner has misapplied the Kudo reference and has made an

unsuggested modification. Accordingly, Applicant submits that the invention, as claimed, is patentable over Kudo in view of Huang and that the rejection should be withdrawn. It is Applicant's position that the combination does not teach the Applicant's basic inventive concept of a semiconductor product comprising three layers: (Layer 1) a low-k dielectric layer, (Layer 2) an oxygen containing layer (e.g., SiO<sub>2</sub>), and (Layer 3) a nitrogen base layer formed of nitrogen-doped silicon carbide (SiC-N), and that the addition of Huang to show an oxygen-containing layer comprised of TEOS contributes no further to the question of the patentability of the claims in as much as following the teachings of Kudo would result in a lack of an oxygen-containing layer altogether.

As such, it is submitted that neither of these references, alone or in combination, describes or suggests the Applicant's invention as claimed. Accordingly, with respect to claims 2, 7, 9, 13, and 14, Applicant submits that the invention, as claimed, is patentable over Kudo in view of Huang and that the rejection should be withdrawn.

*C. The rejection of Claims 5, 8, 10, 12, and 15 - 17 as unpatentable (35 U.S.C. 103) over Kudo (U.S. Patent No. 6,420,261) in view of Huang (U.S. Patent No. 6,191,028) further in view of Liu (U.S. Patent No. 6,323,121).*

With respect to dependent claims 5, 8, 10, and 12, each of said claims depends on Claim 1. As set forth with respect to Issue A, Independent Claim 1 is directed to a semiconductor product comprising three layers: (Layer 1) a low-k dielectric layer, (Layer 2) an oxygen containing layer (e.g., SiO<sub>2</sub>), and (Layer 3) a nitrogen base layer formed of nitrogen-doped silicon carbide (SiC-N). As such, the arguments with respect to the patentability of Claim 1 apply equally to claims 5, 8, 10, and 12.

With respect to claims 15 - 17, each of said claims depends on Claim 13, which includes a layer of nitrogen-doped silicon carbide (as in Claim 1). As such, the arguments with respect to the patentability of Claim 1 apply equally to claims 15 - 17.

In addition to the above-noted arguments with respect to claim 1, Kudo, the primary reference, teaches nothing about using an oxygen-containing layer comprised of oxygen-doped

silicon carbide (Claim 5) nor using an oxygen-containing layer comprised of TEOS (Claim 8, and 15 – 17). Huang describes an insulation-masking layer formed by CVD using TEOS. Liu describes a wafer substructure 10, insulative layer 12, silicon nitride layer 16, low-k dielectric layer 18, silicon nitride layer 20, second low-k dielectric layer 22, silicon oxynitride layer 24.

As set forth above with respect to Issues A and B, had the examiner employed the actual teachings of Kudo, he would have substituted the SiC film for the SiO<sub>2</sub> film resulting in a semiconductor product lacking an oxygen-containing layer required by the claims. The product would then, necessarily, lack an oxygen-containing layer comprised of oxygen-doped silicon carbide or TEOS, even if combined with Huang and/or Liu.

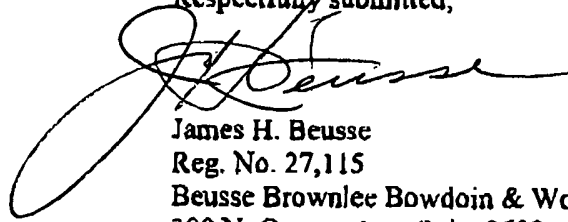
Accordingly, Applicant submits that the invention, as claimed, is patentable over Kudo in view of Huang and Liu and that the rejection should be withdrawn. It is Applicant's position that the combination does not teach the Applicant's basic inventive concept of a semiconductor product comprising three layers: (Layer 1) a low-k dielectric layer, (Layer 2) an oxygen containing layer (e.g., SiO<sub>2</sub>), and (Layer 3) a nitrogen base layer formed of nitrogen-doped silicon carbide (SiC-N), and that the addition of Huang to show an oxygen-containing layer comprised of TEOS contributes no further to the question of the patentability of the claims in as much as the proper combination would result in a lack of an oxygen-containing layer altogether.

As such, it is submitted that none of these references, alone or in combination, describes or suggests the Applicant's invention as claimed. Accordingly, with respect to claims 5, 8, 10, 12, and 15 - 17, Applicant submits that the invention, as claimed, is patentable over Kudo in view of Huang and/or Liu, and that the rejection should be withdrawn.



In view of the foregoing, Applicant urges that the Board overrule the outstanding rejections, and that this application be passed to issuance.

Respectfully submitted,

A handwritten signature in black ink, appearing to read 'J. Beusse', with a large, stylized loop at the beginning.

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Attachment: Appendix

APPENDIX (37 C.F.R. 1.192(c)(7))

Claims on Appeal:

1. A semiconductor product comprising:  
a low-k dielectric layer;  
a nitrogen base layer formed of nitrogen-doped silicon carbide and including N-H base groups capable of diffusing therefrom; and  
an oxygen-containing layer interposed directly between said low-k dielectric layer and said nitrogen base layer.
2. The semiconductor product as in claim 1, wherein said oxygen-containing layer comprises a TEOS (tetraethyl orthosilicate) oxide film
4. The semiconductor product as in claim 1, wherein said nitrogen base layer comprises one of a barrier layer film, an etch-stop layer, and a hardmask film.
5. The semiconductor product as in claim 1, wherein said oxygen-containing layer comprises oxygen-doped silicon carbide.
6. The semiconductor product as in claim 1, wherein said nitrogen base layer comprises a surface of a further film.
7. The semiconductor product as in claim 1, in which said semiconductor product includes:  
a lower low-k dielectric layer disposed over a barrier layer;  
an etch-stop layer disposed over said lower low-k dielectric layer;  
an upper low-k dielectric layer disposed over said etch-stop layer;  
a hardmask layer disposed over said upper low-k dielectric layer;  
said nitrogen base layer comprising one of said barrier layer and said etch-stop layer; and  
said oxygen-containing layer comprising a TEOS oxide layer interposed between said

nitrogen base layer and one of said lower low-k dielectric layer and said upper low-k dielectric layer.

8. The semiconductor product as in claim 7, further comprising each of said barrier layer, said etch-stop layer and said hardmask layer being a nitrogen base layer, and a TEOS oxide layer interposed between each said nitrogen base layer and each said adjacent low-k dielectric layer.

9. The semiconductor product as in claim 7, wherein said barrier layer comprises one of said nitrogen base layer formed of nitrogen-doped silicon carbide, and silicon nitride; and said etch-stop layer comprises the other of said nitrogen base layer formed of nitrogen-doped silicon carbide, and silicon nitride.

10. The semiconductor product as in claim 1, wherein said N-H base groups comprise one of amines and amino-silicates.

11. The semiconductor product as in claim 1, wherein said low-k dielectric layer includes a dielectric constant less than 3.5.

12. The semiconductor product as in claim 1, wherein said low-k dielectric layer comprises one of an organo-silicate-glass and SiOC-H.

13. A semiconductor product comprising:  
a barrier layer formed over a substrate;  
a lower low-k dielectric layer formed over said barrier layer;  
an etch-stop layer formed over said lower low-k dielectric layer;  
an upper low-k dielectric layer formed over said etch-stop layer;  
a hardmask layer disposed over said upper low-k dielectric layer; and  
a TEOS (tetraethyl orthosilicate) oxide film interposed at least one of between said lower low-k dielectric layer and said barrier layer, between said lower low-k dielectric layer and said

etch-stop layer, between said etch-stop layer and said upper low-k dielectric layer, and between said upper low-k dielectric layer and said hardmask,

at least one of said barrier layer and said etch-stop layer formed of nitrogen-doped silicon carbide.

14. The semiconductor product as in claim 13, wherein each of said barrier layer and said etch-stop layer include N-H base groups therein.

15. The semiconductor product as in claim 13, in which a two-tiered opening is formed to extend through said hardmask layer, said upper low-k dielectric layer, said etch-stop layer, said lower low-k dielectric layer, and said barrier layer.

16. The semiconductor product as in claim 15, further comprising a conductive material filling said two-tiered opening, said conductive material serving as an interconnect medium.

17. The semiconductor product as in claim 13, in which an opening is formed to extend through said hardmask layer, said upper low-k dielectric layer, said etch-stop layer and said lower low-k dielectric layer, and further comprising a DUV photoresist formed within said opening.

26. A semiconductor product comprising:  
a low-k dielectric layer;  
a nitrogen base layer including N-H base groups capable of diffusing therefrom; and  
an oxygen-doped silicon carbide layer interposed directly between said low-k dielectric layer and said nitrogen base layer.

27. The semiconductor product as in claim 26, wherein said nitrogen base layer is formed of nitrogen-doped silicon carbide.